

Claims

- 5
1. A photonic device comprising:
- a first section including a material adapted to interact with photons,
- a second section including a material adapted to
- 10 interact with photons,
- with an area of said first section and an area of said second section abutting each other
- characterized in that
- at least a part of said first area and a part of said
- 15 second area define a low temperature bonding area.
2. A photonic device according to claim 1, wherein said low temperature bonding area connects said first area and said second area mechanically and optically.
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3. A photonic device according to claim 2, wherein said low temperature bonding area comprises a surface area of said first section and a surface area of said second section which are connected by means of a low temperature bonding method.
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4. A photonic device according to claim 1, wherein said interaction with photons comprises one or more interaction types of the group of interactions consisting of transmission of photons, reflection of photons, absorption of photons,
- 30 generation of photons, emission of photons, wavelength conversion of photons, guiding of photons, diffraction of photons, refraction of photons, superimposing photons, generation of photon interference and linear, elliptic and

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~~circular polarization of photons.~~

5 5. A photonic device according to claim 1, wherein said second section is a surface area between a first section and a third section.

10 6. A photonic device according to claim 1 wherein said first section comprises a block of glass with a waveguide and said second section comprises an optical fiber.

15 7. A photonic device according to claim 1, wherein said first material has at least a portion where an index of refraction is different from an index of refraction of at least a portion of said second material.

20 8. A photonic device according to claim 7, wherein said photonic device is a wave guide defined in a surface area of said first material and said waveguide is covered by said second material.

25 9. A photonic device according to claim 8, wherein an essentially two-dimensional optical chip is defined with waveguides connecting active and passive optical components.

30 10. A photonic device according to claim 7, wherein said waveguide is defined in a bulk area of the first material.

11. A photonic device according to claim 10, wherein said waveguide extends oblique to a surface of said first material.

12. A photonic device according to claim 10, wherein said waveguide in said first material is connected to a waveguide

extending in said second material.

13. A photonic device according to claim 10 wherein, an essentially three-dimensional optical chip is defined with waveguides connecting active and passive optical components.

14. A photonic device according to claim 13, wherein said first section comprises a waveguide extending in a bulk material and said second section comprises an optical fiber.

15. A photonic device according to claim 1, wherein said photonic device is a transmitter and said first section comprises a light source and said second section comprises a splitter for splitting a propagation path of photons emitted by the light source into a plurality of propagation paths.

16. A photonic device according to claim 15, wherein said splitter comprises a material adapted to amplify light from said light source.

17. A photonic device according to claim 16, wherein said material is an active phosphate laser glass.

18. A photonic device according to claim 15, wherein a distributed Bragg reflector is connected at least to one branch of the splitter.

19. A photonic device according to claim 15, wherein a modulator is connected to at least one branch of the splitter for modulating one element of the group consisting of a phase of photons, an intensity of photons and a polarization of photons, said photons being propagating through said modulator.

20. A photonic device according to claim 19, wherein a combiner is connected to the modulator for combining propagation paths of photons and providing a combined propagation path for the A photons.

21. A photonic device according to claim 20, wherein an optical amplifier is connected to the combiner for amplifying light which propagated through the combiner.

22. A photonic device according to claim 1, wherein said photonic device is a transmitter and said first section comprises a light source, said light source being an element of the group consisting of light emitting diodes, laser diodes, diode arrays, laser diode arrays, vertical cavity surface emitting lasers (VCSELs), arrays of vertical cavity surface emitting lasers (VCSELs) and glass based laser sources, and

said second section comprises an element of the group consisting of wave guides, optical fibers, beam splitters, Bragg reflectors, distributed Bragg reflectors, tunable Bragg reflectors, light modulators and wavelength dependent absorbers.

23. A photonic device according to claim 1, wherein said photonic device is an amplifier and said first section comprises a wavelength dependent splitter splitting different wavelength bands into different propagation paths and said second section comprises an amplifying material at least for one of the wavelength bands associated with one of the propagation paths of the wavelength dependent splitter.

24. A photonic device according to claim 23, wherein said wavelength dependent splitter splits light into a plurality of different wavelength bands each of the different wavelength bands associated with a different propagation path and said second section comprises a plurality of portions comprising an amplifying material associated with at least one of the wavelength bands associated.

25. A photonic device according to claim 24, wherein each of the portions comprising amplifying material contains a dopant being a rare earth element adapted in its amplifying characteristics to said associated wavelength band for amplifying light of the said associated wavelength band.

26. A photonic device according to claim 25, wherein each of the portions comprising amplifying material is optically pumped by a diode laser light source adapted to an absorption characteristic of said portion comprising amplifying material.

27. A photonic device according to claim 26, wherein said splitter is an arrayed waveguide grating and splits light into transmission bands essentially centered at 1,3 μm , 1,4 μm and 1,5 μm , said 1,3 μm transmission band being associated with a Praseodym doped Chalcogenide glass and said associated diode laser light source having a pump light wavelengths centered at about 1020 nm, said 1,4 μm transmission band being associated with a Tm doped Fluoride glass and said associated diode laser light source having a pump light wavelengths centered at about 800 nm and said 1,5 μm transmission band being associated with an Erbium doped Phosphate glass and said associated diode laser light source having a pump light wavelengths centered at about 980 nm.

28. A photonic device according to claim 23, wherein a combiner combines propagation paths extending through said plurality of portions comprising amplifying material and is
5 connected to a waveguide for transmitting amplified light.

29. A photonic device according to one of claim 1, wherein said photonic device is an amplifier having a plurality of amplification portions comprising amplifying material and
10 arranged serially in a direction of the propagation of light and wherein said first section comprises a first amplification portion and said second section comprises a second amplification portion.

30. A photonic device according to claim 29, wherein each of the amplifying materials is containing a dopant being a rare earth element adapted in its amplifying characteristics to an associated wavelength band for amplifying light of said
15 associated wavelength band.

31. A photonic device according to claim 30, wherein each of the portions comprising amplifying material is optically pumped by a diode laser light source adapted to an absorption characteristic of said amplifying material.
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32. A photonic device according to claim 29, wherein said plurality of amplification portions define an overall gain which has an increased gain over an extended wavelength interval in comparison to one of the said amplification
25 portions.
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33. A photonic device according to claim 1, wherein said photonic device is a receiver and said first section

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comprises a photo detector and said second section comprises at least a waveguide for guiding photons to the photo detector.

5 34. A photonic device according to claim 33, wherein said
photo detector is a photo diode.

35. A photonic device according to claim 33, wherein said
second section comprises an light amplifying material for
10 amplification of photons propagating in said waveguide.

36. A photonic device according to claim 35, wherein said amplifying material comprises a rare earth dopant which is optically pumped by a light source.

37. A photonic device according to claim 36, wherein said optical pump light source is a laser diode pump laser.

38. A photonic device according to claim 37, wherein a
20 waveguide section is connected with said amplifying material
and wherein a photo diode is connected to a waveguide of said
waveguide section for controlling a pump light intensity of a
laser diode pump light source associated with said amplifying
material.

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39. A photonic device according to claim 1, wherein
said photonic device is an optical add drop multiplexer
and

30 said first section comprises a demultiplexer for
demultiplexing light into a plurality of propagation paths
and

said second section comprises optical switching means for switching between light from the multiplexer and added

45. A photonic device according to claim 1, wherein said photonic device has at least a first waveguide in said first section comprising a material having an index of refraction n_1 with a positive temperature coefficient $\partial n_1 / \partial T$ and with at least second waveguide in said second section comprising a material having an index of refraction n_2 with a negative temperature coefficient $\partial n_2 / \partial T$ said first and said second waveguides being optically connected to each other.

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46. A photonic device according to claim 45, wherein an overall temperature coefficient of an effective index of refraction encountered by a photon propagating through the first and second waveguide is essentially temperature independent.

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47. A photonic device according to claim 45, having a third section comprising a material having an index of refraction n_3 with a positive temperature coefficient $\partial n / \partial T$ with a third waveguide in said third section optically connected to said second waveguide.

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48. A photonic device according to claim 47, wherein an overall temperature coefficient of an effective index of refraction encountered by a photon propagating through the first, second and third waveguide is essentially temperature independent.

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49. A photonic device according to claim 45, wherein said photonic device is a mutliplexer/demultiplexer comprising a plurality of first waveguides, a plurality of second waveguides and a plurality of third waveguides.

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50. A photonic device according to claim 1, wherein at least one material adapted to interact with photons is not a phosphate glass.

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List of Numerals

	1	first embodiment of photonic device
	2	optical substrate defining first section
5	3	upper surface of optical substrate 2
	4	waveguide
	5	second section
	6	lower surface of second section 5
	7	three-dimensional waveguide structure
10	8	optical fibre
	9	cube
	10	cube
	11	cube
	12	cube
15	13	cube
	14	cube
	15	waveguide
	16	waveguide
	17	front surface
20	18	front surface
	19	branch of waveguide splitter
	20	branch of waveguide splitter
	21	branch of waveguide splitter
	22	branch of waveguide splitter
25	23	bend in waveguide
	24	bend in waveguide
	25	connection to waveguide
	26	connection to waveguide
	27	waveguide
30	28	waveguide
	29	optical fiber
	30	optical fiber
	31	waveguide
	32	waveguide
35	33	optical fiber
	34	first section of fourth embodiment
	35	light source
	36	second section of fourth embodiment
	37	splitter
40	38	propagation path
	39	propagation path
	40	propagation path
	41	propagation path
	42	low temperature bonding area
45	43	Bragg grating
	44	modulator
	45	electrode pair
	46	electrode pair
	47	electrode pair

	48	combiner
	49	combined propagation path
	50	optical amplifier
	51	doped glass substrate
5	52	pump laser light source
	53	optical fiber
	54	low temperature bonding area
	55	optical fiber
	56	propagation path
10	57	propagation path
	58	propagation path
	59	wavelength dependent splitter
	60	optical amplifier
	61	optical amplifier
15	62	optical amplifier
	63	low temperature bonding area
	64	combiner
	65	combined propagation path
	66	optical fiber
20	67	silicate glass body
	68	light source
	69	light source
	70	light source
	71	optical amplifier
25	72	optical amplifier
	73	low temperature bonding area
	74	optical fiber
	75	low temperature bonding area
	76	optical propagation path
30	77	pump light source
	78	pump light source
	79	photo detector
	80	photo detector
	81	low temperature bonding area
35	82	optical fiber
	83	photo diode
	84	photo diode
	85	photo diode
	86	optical amplifier
40	87	optical amplifier
	88	optical amplifier
	89	optical fiber
	90	arrayed waveguide grating
	91	low temperature bonding area
45	92	optical propagation path
	93	optical propagation path
	94	optical propagation path
	95	photo diode
	96	photo diode

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|----|-----|--|
| | 97 | laser diode light source |
| | 98 | laser diode light source |
| | 99 | laser diode light source |
| | 100 | photo diode |
| 5 | | |
| | 101 | arrayed waveguide grating |
| | 102 | optical fiber |
| | 103 | propagation path |
| | 104 | propagation path |
| 10 | 105 | propagation path |
| | 106 | propagation path |
| | 107 | Mach Zehnder interferometer |
| | 108 | Mach Zehnder interferometer |
| | 109 | Mach Zehnder interferometer |
| 15 | 110 | Mach Zehnder interferometer |
| | 111 | propagation path |
| | 112 | propagation path |
| | 113 | propagation path |
| | 114 | propagation path |
| 20 | 115 | passive glass of Mach Zehnder interferometer |
| | 116 | passive glass of Mach Zehnder interferometer |
| | 117 | thermo-optical glass or electro-optical material |
| | 118 | branch of Mach Zehnder interferometer |
| | 119 | branch of Mach Zehnder interferometer |
| 25 | 120 | exit of Mach Zehnder interferometer |
| | 121 | exit of Mach Zehnder interferometer |
| | 122 | drop signal propagation path |
| | 123 | drop signal propagation path |
| | 124 | drop signal propagation path |
| 30 | 125 | propagation path to combiner |
| | 126 | propagation path to combiner |
| | 127 | propagation path to combiner |
| | 128 | propagation path to combiner |
| | 129 | propagation path to combiner |
| 35 | 130 | combiner |
| | 131 | optical amplifier |
| | 132 | optical fiber |
| | 133 | optical fiber |
| | 134 | coupler/splitter |
| 40 | 135 | first array of waveguides in first section |
| | 136 | second array of waveguides in second section |
| | 137 | third array of waveguides in third section |
| | 138 | coupler/combiner |
| | 139 | optical fiber |
| 45 | 140 | optical fiber |
| | 141 | optical fiber |
| | 142 | optical fiber |
| | 143 | low temperature bonding area |
| | 144 | low temperature bonding area |